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LOCKHEED MARTIN

DATE: April 30, 2008

THROUGH: Dennis Miller, REAC Acting Operations Section Leader

FROM: Christopher Gussman, REAC Task Leader

SUBJECT: SUMMARY EVALUATION OF LOWER SILVER CREEK SOIL AND GROWTH ROOM STUDIES
LOWER SILVER CREEK TAILINGS SITE
WORK ASSIGNMENT 0-300
TECHNICAL MEMORANDUM

Introduction

This technical memorandum summarizes soil characterization and relative plant growth studies for four soil samples collected from the Lower Silver Creek Tailings Site. Lockheed Martin's Response Engineering Analytical Contract (REAC) was tasked to chemically and agriculturally characterize soil provided from the site. Part of this evaluation was to determine the effect of a locally available biosolids and/or biosolids compost source on the soil chemistry and plant growth in these soils. Contaminated soil (tailings) cover a large area of the site, and an effective way to revegetate the area and/or bind metals of interest would be more economic than removal.

The U.S. Environmental Protection Agency (U.S.EPA) Work Assignment Management (WAM), under guidance of Region VIII EPA, collected soil from four representative locations on the site. One 5-gallon bucket of each of these soils, labeled "Location 1" through "Location 4", were sent to the REAC facility along with one 5-gallon bucket each of biosolids and biosolids compost. Location 1 is from a wetter (possible wetland) area of the site than the other three, but all four locations represent soil (tailings) conditions typical of large areas of the site.

Background

From the mid-1800s through the 1970s, this region was extensively mined for silver and lead ores. Although some remediation has occurred, residual deposits of tailing wastes remain in place along large sections of the Lower Silver Creek. Bed sediment samples were collected by the USGS in 1998, 1999, and 2000 and analyzed. Water samples were collected in March and August 2000 and were analyzed for total and dissolved trace metals.

Concentrations of silver, cadmium (Cd), copper (Cu), lead (Pb), mercury (Hg), and zinc (Zn) in the streambed sediment of Silver Creek greatly exceeded background concentrations. These metals also exceeded established aquatic life criteria at most sites. In the Weber River, downstream of the confluence with Silver Creek, concentrations of Cd, Pb, Zn, and total Hg in streambed sediment also exceeded aquatic life guidelines, however, concentrations of metals in streambed sediment of McLeod and Kimball Creeks were lower than Silver Creek. Water-column sampling showed concentrations of zinc, total mercury, and methylmercury in Silver Creek were high relative to unimpacted sites, and exceeded water quality criteria for the protection of aquatic organisms. Qualitative measurements of the macroinvertebrate community in Silver Creek were compared to the spatial distribution of metals in streambed sediment. The data indicate that impairment related to metal concentration exists in Silver Creek.

The Lower Silver Creek Tailings Site extends over 12 miles along the banks of Silver Creek, from State Route 248 north of Richardson Flat, two miles east of Park City, Summit County, Utah. The site has been subdivided into southern and northern portions, due to the site conditions and topography. The northern portion of the site consists of a narrow corridor located between the lanes of interstate 80 (I-80) which includes the rail trail, Silver Creek and the riparian habitat. The southern portion of the site is approximately 4.4 miles in length between Atkinson and State Route 248, and is as much as 2,500 wide, east to west. The southern portion of the site upstream from Atkinson is being developed by residential and commercial expansion.

The headwaters of Silver Creek are located upgradient of Park City. Silver Creek is the primary drainage within the watershed downstream to the Weber River confluence in Wanship, Utah. The Weber River is considered a Class 4 (agricultural), 3A (cold water fishery), 2B (contact recreation), 1C (source of drinking water) river. Silver Creek is considered a Class 3A, 1C and 4 stream.

Mine tailings generally cover the entire southern portion of the Lower Silver Creek. Tailings are readily apparent in the non-vegetated gray colored sandy and gravelly mounds and low ridges within the riparian habitat along Silver Creek. Elongated berms trend north-south and are found throughout the entire southern portion of the Lower Silver Creek.

The northern portion of the Lower Silver Creek is a generally well vegetated riparian habitat. A beaver dam was observed upstream from Alexander Canyon. Fish were observed in Silver Creek at a few locations. Various bird species have been reported along the banks of the Silver Creek. Mine tailings have reportedly not been observed more than one mile north and downstream of Atkinson.

The area impacted by this site is too large for conventional treatment such as removal. It is anticipated that compost and possibly other soil amendments may be utilized to enhance vegetative cover establishment at the site and possibly reduce mobility of the metal contaminants.

Soil Analysis

Soils from the four locations were received at the REAC facility in 5-gallon buckets, one bucket per soil type. The soil was thoroughly mixed by hand. Large stones, sticks, etc. were removed from the soil and discareded. However, the soil was found to be relatively uniform upon receipt and large debris was minimal. Subsamples from each of the four locations, the biosolids, and the biosolids compost were sent to Rutgers University Soil Testing Laboratory for agricultural analysis, and another subsample was sent to the REAC laboratory for chemical analysis of the metals of interest. A summary of the results is presented in Table 1. The biosolids and biosolids compost were also analyzed.

Chemical analysis results are included in Appendix A, agricultural analysis results are included in Appendix B. The soils from Location 2 and Location 4 were somewhat similar to each other in appearance and chemistry. These middle soils were selected for later, additional testing (additional plant growth and the soil pore water extraction below). Location 1 was from a wetter area of the site and had more organic material and less soluble salt than the other 3 soils. Soil from Location 3 was the most problematic for plant growth, probably due to the lower pH effect on metal availability, and the much higher soluble salt. Metals of concern were high in all four soils, particularly Pb, Zn, and Cu. Electrical conductivity was found to be high in all four soilsamples which may burn plant roots of many species. However, pH was close to neutral for three of the soils which is ideal for plant growth given the higher metal contaminants.

All soils were deficient in macronutrients, especially Phosphorus (P). Micronutrients, especially Zn and Cu, were extremely high and may cause plant toxicity. The four soils were all identified as Sandy Loams.

At the request of the WAM, the four soils were analyzed to determine if they are acid producing soils. However, none of the soils were found to be acid producing.

Growth Room Studies

Growth room experiments were conducted at the ERT/REAC Biology Laboratory to evaluate plant growth on the soil provided from the site (Figure 1). Oats (*Avena sativa*) were selected to test the effectiveness of locally available biosolids and compost to immobilize contaminants and to promote plant growth in the four soils collected from the Site. These experiments were designed to evaluate the effect of biosolids, compost, and additional soil amendments such as lime and P on plant germination, survival and growth in the four sources of contaminated soil. Oats were selected because they germinate and grow quickly, thus providing a means of evaluating germination and relative growth in a short time frame.

Four sources of site soil (Location 1, Location 2, Location 3 and Location 4) were evaluated. Each of these soils was also amended with 10 percent volume/volume (v/v) biosolids or biosolids compost obtained from a commercial source near the site and also provided to REAC scientists by EPA, along with the site soils. A commercial potting soil was used as the control for optimal plant growth. The soils were air-dried until suitable for handling. The air-dried soil was then thoroughly mixed. Large debris (stones, leaves) were removed and discarded. Appropriate amounts of soil and biosolids compost were mixed to achieve the designed biosolids compost application rates for each treatment as follows:

1. 100% Site Soil
2. Soil + 10% biosolids v/v
3. Soil + 10% biosolids compost, v/v
4. Soil + 2.5 mg/L Phosphorus (as bone meal)
5. Soil + 10% biosolids + 2.5 mg/L Phosphorus (as bone meal),
6. Potting Soil (Control)

Treatments 1 through 3 were replicated three times for all four soils., and treatment four and five were replicated three times for only soil from Location 3. Treatment 4 and 5 were added because initial chemical and agricultural analysis of the soils showed that the soils were very low in available P and supplemental P may also reduce availability of heavy metals such as Pb. The soil and amendments were thoroughly mixed. Each pot (4.5 inch) received 0.5 liter (L) of mixed soil. The pots were placed in the ERT/REAC growth room for two days before planting to allow the soil to reach equilibrium with the biosolids compost. Water was added to the pots as needed to keep soil moisture at field capacity. Soil pH was monitored periodically using 1:1 water extraction for each treatment during the two-week incubation period.

Fifteen (15) oat seeds (*Avena sativa*)were placed uniformly on the soil surface of each pot, and the seeds were pushed down approximately one centimeter (cm) below the soil surface. The plants were grown in the ERTREAC growth room with a 16-hour (h), 25 degree centigrade (°C) / 8 h 20 °C day/night cycle.

Plant germination and survival were observed and noted over the course of the germination. The growth experiment was terminated four weeks after seeding. Germination and plant biomass may be viewed in Table 2 and Figures 2a through 2c. Seeds germinated fine on all soils and treatments, although they were slightly delayed on soil 3 with the addition of supplemental P. However, these later plants showed better coloration than the other seedlings. All seeds had germinated within a week, most within 5 days. Although seedlings of all treatments looked good initially, most seedlings began to show symptoms of toxicity (yellowing of leaves) after about two weeks. Plants in the potting soil control grew largest and the leaves remained a uniform dark green.

Plant Sampling. At the end of the first plant bioassay experiment (four weeks), the final number of plants surviving in each pot of the first experiment was recorded. The above ground plant biomass from each pot was then cut at the soil surface to evaluate the effect of biosolids compost application on plant growth. The samples were placed in appropriately labeled paper bags after the fresh weight was recorded. Samples were dried at 70 degrees Centigrade (°C) for 48 hours and the dry weight recorded.

For all soils, plant growth on soil with the added biosolids compost performed better than plants on soil with added biosolids which performed better than unamended soil (Tables 2a and 2b). The addition of a compost greatly improved overall plant growth. Untreated soil from Location 1 performed better than the untreated soil from the other three Locations, but all of the untreated soils performed poorly. Plants on soil from Location 1 with the addition of biosolids compost performed reasonably well. Because of toxicity and/or nutrient deficiency symptoms observed in most of the treatments, a second growth room study was initiated using additional soil amendments and one of the two "middle" performance soils (Location 2). The biosolids compost was chosen over the biosolids for additional testing due to its better performance in stimulating plant growth, and the fact that biosolids alone would not likely be selected for use in the field due to the proximity of the river body at the site. Oats on soil from Location 3 with supplemental P looked very good at germination, but later exhibited toxicity symptoms. However, Location 3 soil was the most problematic site soil and this treatment was repeated. In addition, the presence of P or Ca may help make other metal contaminants less bioavailable. Therefore treatments further tested were as follows:

1. 100% Site Soil (Location 2)
2. Soil + 10% biosolids compost, v/v
3. Soil + 2.5 mg/kg Phosphorus (as bone meal)
4. Soil + 10% biosolids + 2.5 mg/L Phosphorus (as bone meal),
5. Soil +5.0 mg/kg Phosphorus (as bone meal)
6. Soil + 2.5 mg/kg Phosphorus (in a "complete" fertilizer)
7. Soil + 10% biosolids compost + 2.5 mg/kg $CaCO_3$
8. Soil + 10% biosolids compost + 2.5 mg/kg Phosphorus (as bone meal) + 2.5 mg/kg $CaCO_3$
9. Potting Soil (Control)

Evaluation was subjective based on relative plant growth and coloration. Weights of plants were not obtained, but visually the combination of biosolids compost and supplemental P performed the best for promoting plant growth and health of the oats, second to the potting soil control (Figures 3a and 3b). As a quick side experiment, Location 3 soil was used to evaluate different lime application rates on plant growth and pH. Because the pH was lowest in this Location 3 soil, it was assumed that lime may be beneficial in raising the pH and binding metals. No replicates were used due to limited remaining soil. Interestingly, the pH was not found to be as low as indicated by the soil testing laboratory. The soil pH did not change greatly even at the high application rate of 5g/L (Table 3), increasing from 6.8 to only 7.24. Plants appeared to grow slightly better at the highest lime application rate but still performed poorly overall.

Soil Pore Water Extraction

As part of this WA, it was requested that a pore water extraction be performed to compare metals solubalized in the pore water of a site soil with amended site soil. Water soluble metals would be more readily available to vegetation, as well as more easily leachable into groundwater and/or other surrounding bodies of water. A slightly higher P application rate was used for this testing, as well as the higher lime application rates, as both of these amendments have been shown to bind up heavy metals (especially Pb) under some conditions.

A commercially available, large volume soil/water sampler designed for near-surface installation at depths ranging from 15 cm to 1.8 meter (m) was used to extract soil pore water (ASTM Committee, 1992). The samplers were purchased from Soil Moisture Equipment Corporation, Goleta, California, Model 1900L06-B02M2. The unit, sometimes called a "suction lysimeter", consists of a 4.8 cm outside diameter polyvinyl chloride (PVC) tube, a porous ceramic cup, and a Santoprene stopper.). The following treatments were selected for the soil pore water extraction. A higher P rate was utililized in the hope that the P would help reduce toxicity of the heavy metals.

1. 100% Site Soil
2. Soil + 10% Biosolid Compost (v/v)
3. Soil + 10% Biosolids Compost(v/v)+ 250 mg/kg P
4. Soil + 10% Biosolids Compost (v/v)+ 250 mg/kg P + 5g/L lime.

Each treatment was replicated three times. Soil and biosolids were prepared in the same manner described for the plant bioassay. Approximately 1500 g of mixed soil was placed in a two-liter (L) plastic container and placed in the laboratory at room temperature (25 °C). Soil was saturated and thoroughly mixed several days before water extraction commenced. During the incubation period, distilled water was added if necessary to keep the soil moisture at field capacity, which was determined before the initiation of soil pore water extraction. The weight of each pot was recorded and maintained Monday through Friday by adding deionized water as needed. After equilibration, the water sampler was installed into the center of the container and the soil pore water was collected 12 hours after installing the pore water sampler. The soil pore water was collected twice a day for five days. The water collected from each replicate pot during the five-day period was combined to yield a composite sample for metal analysis for each replicate of a treatment. The soil pore water was preserved at a pH of 2 and a temperature of 4 °C.

Soluble Cu and Mg increased with the compost addition, but the soluble Cu was relatively low anyway and the increase insoluble Mg should not be problematic. Although Pb is present in this soil at high concentrations, it was not found in the pore water of any of the samples, amended or unamended. Analytical results for the pore water extraction may be found in Appendix A.

Conclusions and Recommendations

Chemical and agricultural analysis of the four site soils from the Lower Silver Creek Tailings Site, in combination with preliminary growth room studies, indicate that it may be challenging but worthwhile to revegetate the site. Revegetation will likely be successful with some soil amending and these amendments may reduce mobility of some of the contaminants of concern.

Additional testing is recommended to fine tune the concentration of soil amendments and species selection. Ideally, test plots should be developed in the field utilizing several amendment combinations and several plant species. This pilot-scale field study would better identify optimum revegetation options under field conditions, and introduce variables that may be present in the field that are not in the laboratory (e.g. local insects and weather). Elevated salinity of the site soils may present problems with revegation efforts, although some of the locallynative plants will be more adapted to the elevated salinity and this needs to be further tested. However, care will be needed not to over apply fertilizers which will further increase soil salinity. The addition of supplemental P is recommended, along with compost. Ten percent compost was selected because it has proved to be a reasonable application rate in our experience. A higher application rate my be beneficial, and should possibly be evaluated in the field, although the increased volume over a large area may make a higher application rate prohibitive during a fullscale effort. Besides supplying nutrients, the compost helps hold water and provide much needed organic matter to this sandy soil. Further laboratory testing may help fine tune amendments and species selection before a pilot scale or full scale revegetation effort takes place. Many native plant species are slow to germinate and grow, and testing would need to occur over a longer time frame.

Upon completion of the pore water extraction, the soil in these containers was mixed and seeded with a combination of western native forbs, and a faster-growing, non-native "wildflower" mixture. Initial growth (testing still in place at the time of this writing) appears poor, but germination consisted primarily of the nonnative "wildflowers" (i.e. *Rudbeckia, Centaurea, Cosmos*) These faster growing dicots are most likely more susceptible to the higher salinity of this soil than Oats or some of the native species adapted to that part of Utah. The plants did show best coloration on the soil amended with compost and P. Additional testing is recommended.

The Utah Native Plant Society may be a beneficial tool in recommending and locating sources for native seed appropriate for Revegetation this site fullscale. http://www.unps.org/index.html

References

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Mehlich A. 1984. Mehlich 3 soil test extractant: A modification of Mehlich 2 extractant. Communication of Soil Science and Plant Analysis. 15:1409-1416.

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Tables

Tables

Table 1
Summary of Soil Analytical Results
Lower Silver Creek Tailings Site
Apr-08

	(mg/kg)	Location 1	Location 2	Location 3	Loc3 Dup	Location 4	Biosolids	Biosolids Compost
Analytical:	Arsenic	448	361	321	263	602	11.7	8.32
	Cadmium	131	79.1	80.3	88.3	141	2.48	2.2
	Copper	1140	498	442	286	1400	552	359
	Iron	16100	47400	50500	57200	14900	19100	14600
	Lead	15900	6400	7440	8510	13900	89.9	45.1
	Mercury	51.8	10.3	4.35	4.27	14.8	1.73	1.59
	Selenium	8.5	17.1	22.8	25.3	7.07	13.8	8.93
	Zinc	23000	15100	14800	15500	36100	936	621
	Aluminum	5190	2330	971	1130	3030	9950	8020
	Magnesium	7590	12300	7700	7700	12000	3940	4650

		Location 1	Location 2	Location 3	Loc3 Dup	Location 4	Biosolids	Biosolids Compost
Agricultural:	pH	6.8	7.25	5.3	x	7.25	6.75	6.9
	Soluble Salt (mmho/cm)*	0.85	1.16	3.19	x	1.23	7.9	9.6
	Phosphorus (lbs./acre)	21	2	3	x	1	12	15
	Potassium (lbs./acre)	51	157	9	x	26	60	500
	Magnesium (lbs.acre)	598	413	1217	x	157	130	176
	Calcium (lbs./acre)	6299	12294	29779	x	6757	518	470
	Gravel (greater than 2mm	15.74	2.94	6.65	x	9.39	x	x
	Sand %	56	68	75	x	69	x	x
	Silt %	28	28	14	x	24	x	x
	Clay %	16	4	11	x	11	x	x
	Texture:	Sandy Loam	Sandy Loam	Sandy Loam		Sandy Loam		
	Soil Organic Matter %	4.92	1.71	0.58		1.13	65.2	67.3
	Organic Carbon %	2.86	0.99	0.34		0.65	37.82	39.03
	Nitrate ppm	x	x	x		x	32	109
	Ammonium ppm	x	x	x		x	675	729

* Note: Soluble Salt Levels are high in all of the soil and soil amendments tested. This may "burn" plant roots.
x= not analyzed.

Table 2a
Weight and Total Oats Per Pot- Growth Room Experiment 1
Lower Silver Creek Tailings Site
Apr-08

Soil	Treatment*	Replicate	# of plants	Fresh Weight (g)	Dry Weight (g)
1	1	A	14	3.5	0.4
1	1	B	14	3.4	0.4
1	1	C	15	3.6	0.4
1	2	A	14	4.4	0.5
1	2	B	11	5.4	0.7
1	2	C	10	3	0.3
1	3	A	12	4.6	0.5
1	3	B	11	6.4	0.7
1	3	C	10	4.5	0.5
2	1	A	13	0.9	0.2
2	1	B	12	0.7	0.2
2	1	C	15	0.9	0.2
2	2	A	12	2.4	0.4
2	2	B	12	2.6	0.4
2	2	C	13	3.5	0.5
2	3	A	14	4	0.5
2	3	B	12	3.3	0.5
2	3	C	9	3.4	0.4
3	1	A	12	0.5	b
3	1	B	13	0.8	b
3	1	C	10	0.6	0.1
3	2	A	12	0.9	0.2
3	2	B	11	0.8	0.2
3	2	C	12	0.7	0.2
3	3	A	11	3.8	0.4
3	3	B	12	3.9	0.5
3	3	C	10	3.8	0.4
3	4	A	13	3.8	0.4
3	4	B	12	4.3	0.4
3	4	C	10	2.9	0.2
3	5	A	13	1.5	0.2
3	5	B	12	1.5	0.2
3	5	C	13	1.5	0.2
4	1	A	14	0.5	0.1
4	1	B	14	0.6	0.2
4	1	C	13	0.8	0.2
4	2	A	15	1.3	0.3
4	2	B	14	1.3	0.2
4	2	C	9	0.7	0.1
4	3	A	13	3.3	0.5
4	3	B	13	3.3	0.4
4	3	C	14	2.7	0.4
Potting Mix		A	15	17.5	1.4
Potting Mix		B	11	9	0.7
Potting Mix		C	12	10.1	0.8

Growth Room Experiment 1, Harvest of Oats after 4 weeks
4.5" pots, 0.5 Liters of soil per pot, 4 weeks growth
*Treatments: 1= Unamended Soil, 2= +10% Biosolids
3= +10% Biosolids Compost, 4= +2.5mg/kg P, 5= + Biosolids Compost +2.5 mg/kg P
b= below 0.1grams
P added as bone meal.

Table 2b
Weight and Total Oats Per Pot- Growth Room Experiment 1
Lower Silver Creek Tailings Site
Apr-08

Soil Location	Treatment	Average Plants/pot	Std. Deviation Plants/Pot	Average Fresh Weight Pot (grams)	Std. Deviation Fresh Weight/ Pot (grams)
1	Untreated	14.33	0.58	3.50	0.10
1	Biosolids	11.67	2.08	4.27	1.21
1	Biosolids Compost	11.00	1.00	5.17	1.07
2	Untreated	13.33	1.53	0.83	0.12
2	Biosolids	12.33	0.58	2.83	0.59
2	Biosolids Compost	11.67	2.52	3.57	0.38
3	Untreated	11.67	1.53	0.63	0.15
3	Biosolids	11.67	0.58	0.80	0.10
3	Biosolids Compost	11.00	1.00	3.83	0.06
3	2.5 mg/kg P	11.67	1.53	3.67	0.71
3	B Compost 2.5 mg/kg P	12.67	0.58	1.50	0.00
4	Untreated	13.67	0.58	0.63	0.15
4	Biosolids	12.67	3.21	1.10	0.35
4	Biosolids Compost	13.33	0.58	3.10	0.35
	Commercial Potting Soil	12.67	2.08	12.20	4.62

Table 3
Lime Application to Soil from Location 3
Lower Silver Creek Tailings Site
Apr-08

Lime Rate g/L	Soil pH Day 1	Day 3	Day 9
0	6.45	6.17	6.69
2	6.64	6.97	7.24
3	6.69	7	7.2
4	6.89	7.2	7.44
5	6.8	7.02	7.24

g/L= grams per liter of soil.

Figures

FIGURE 1
POTS OF OATS GROWING ON SOIL
FROM THE LOWER SILVER CREEK TAILING SITE
LOWER SILVER CREEK TAILING SITE
PARK CITY, UTAH
APRIL 2008

U.S. EPA ENVIRONMENTAL RESPONSE TEAM
RESPONSE ENGINEERING AND ANALYTICAL CONTRACT
EP-C-04-032
W.A.# 0 - 300

REAC4/300/300_FIG1.DWG 04/24/08

U.S. EPA ENVIRONMENTAL RESPONSE TEAM
RESPONSE ENGINEERING AND ANALYTICAL CONTRACT
EP-C-04-032
W.A.# 0 - 300

FIGURE 2
GROWTH OF OATS ON SOIL
FROM LOCATIONS 1 THROUGH 4
LOWER SILVER CREEK TAILING SITE
PARK CITY, UTAH
APRIL 2008

REAC4/300/300_FIG.2.DWG 04/24/08

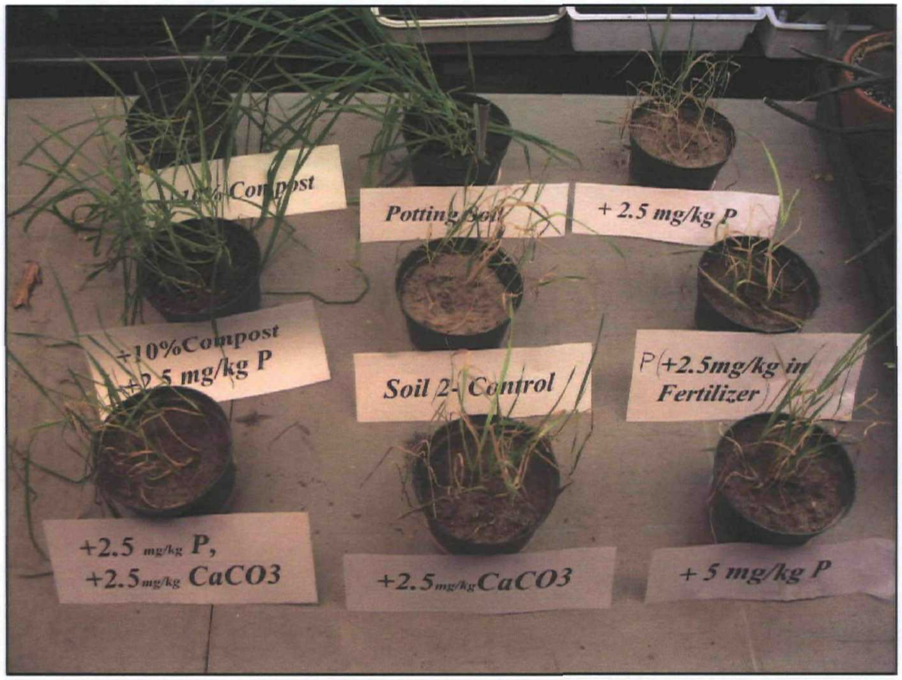

Figure 3a
Overall comparison of nine different treatments on soil from Location 2

Figure 3b
Comparison on the Potting Soil Control (left) with the best amendment (right), + 10% compost + 2.5 mg/kg Phosphorus

U.S. EPA ENVIRONMENTAL RESPONSE TEAM
RESPONSE ENGINEERING AND ANALYTICAL CONTRACT
EP-C-04-032
W.A.# 0 - 300

FIGURE 3a & 3b
LOWER SILVER CREEK TAILING SITE
PARK CITY, UTAH
APRIL 2008

REAC4/300/300_FIG.2.DWG 04/24/08

Appendix A

Lockheed Martin Technology Services Group
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LOCKHEED MARTIN

DATE: 01/15/08

TO: Mr. Raj Singhvi, U. S. EPA/ERT

Thru: Vinod Kansal, Analytical Section Leader, REAC Jay Patel for V Kansal

FROM: Jay Patel, Inorganic Group Leader, REAC Jay Patel

SUBJECT: Preliminary Results of Project: Lower Silver Creek Tailing WA# EAC003C0

Attached please find the preliminary results of the above referenced project for the following samples.

NO QC EVALUATION/VALIDATION HAS BEEN PERFORMED
DATA VALIDITY IS UNSUBSTANTIATED
AND THE DATA SHOULD BE USED WITH DISCRETION

Chain of Custody No.	# of samples	Matrix	Analyses
300-01/07/08-0001	8	soil	Al & Mg metals.

CC: Central File # EAC003C0

Vinod Kansal · Analytical Section Leader, REAC

G. Newhart Work Assignment Manager, U. S. EPA/ERT

C. Gussman Task Leader, REAC

L. Martin, Hazardous Waste Co-ordinator, REAC

Method REAC SOP 1811

Table 1.x (cont.) Results of the Analysis for Metals in Soil
WA # 0-300 Lower Silver Creek tailings site
Results Based on Dry Weight
NO QC EVALUATION / VALIDATION HAS BEEN PERFORMED

Sample No.	Method Blank-011008		300-0001		300-0002		300-0003		300-0004		300-0005	
Location	Lab		Location 1		Location 2		Location 3		Location 3B		Location 4	
% Solids	NA		81		86		93		94		91	
Analyte	Result mg/kg	RL mg/kg	Result mg/kg	RL mg/kg	Result mg/kg	RL mg/kg	Result mg/kg	RL mg/kg	Result mg/kg	RL mg/kg	Result mg/kg	RL mg/kg
Aluminum	U	20.0	5190	22.9	2330	21.7	971	20.3	1130	20.1	3030	20.7
Magnesium	U	20.0	7590	22.9	12300	21.7	7700	20.3	7850	20.10	12000	20.7

RL denotes Reporting Limit
U denotes Not Detected

Method REAC SOP 1811

Table 1.x (cont.) Results of the Analysis for Metals in Soil
WA # 0-300 Lower Silver Creek tailings site
Results Based on Dry Weight
NO QC EVALUATION / VALIDATION HAS BEEN PERFORMED

Sample No.	300-0006		300-0007		300-0008	
Location	Biosolids		Compost		Organic Soil	
% Solids	22		83		77	
Analyte	Result mg/kg	RL mg/kg	Result mg/kg	RL mg/kg	Result mg/kg	RL mg/kg
Aluminium	3950	72.7	5020	23.9	4000	24.7
Magnesium	3940	72.7	4650	23.9	1750	24.7

RL denotes Reporting Limit
U denotes Not Detected

EP-C-04-032

CHAIN OF CUSTODY RECORD

No: 300-01/07/08-0001

Site #: 300

Contact Name: Chris Gussman

Contact Phone: 732-321-4237

Lab: REAC

Lab #	Sample #	Location	Analyses	Matrix	Collected	Numb Cont	Container	Preservative	MS/MSD
16130	300-0001	Location 1	TAL metal including Hg	Soil	1/7/2008	1	8 oz jar	4 C	
16131	300-0002	Location 2	TAL metal including Hg	Soil	1/7/2008	1	8 oz jar	4 C	
16132	300-0003	Location 3	TAL metal including Hg	Soil	1/7/2008	1	8 oz jar	4 C	Y
16133	300-0004	Location 3B	TAL metal including Hg	Soil	1/7/2008	1	8 oz jar	4 C	
16134	300-0005	Location 4	TAL metal including Hg	Soil	1/7/2008	1	8 oz jar	4 C	
16135	300-0006	Biosolids	TAL metal including Hg	Biosolids	1/7/2008	1	8 oz jar	4 C	
16136	300-0007	Compost	TAL metal including Hg	Compost	1/7/2008	1	8 oz jar	4 C	
16137	300-0008	Organic Soil	TAL metal including Hg	Organic Soil	1/7/2008	1	8 oz jar	4 C	
	~~300-0009~~	~~Sand~~	CG ~~TAL metal including Hg~~	~~Sand~~	~~1/7/2008~~	~~1~~	~~8 oz jar~~	~~4 C~~	

CG

Special Instructions: TAL Metal analysis including Hg – NO DATA VALIDATION CD
Fe, Cu, Zn, Cd, Se, As, Pb + Hg

Received 4°C JM 1/9/08

SAMPLES TRANSFERRED FROM
CHAIN OF CUSTODY #

Items/Reason	Relinquished by	Date	Received by	Date	Time	Items/Reason	Relinquished By	Date	Received by	Date	Time
8/Analysis	[signature]	1/9/08	[signature]	1/9/08	15:00	All/Analysis	[signature]	1/9/08	[signature]	1/9/08	3:25

Lockheed Martin Technology Services Group
Environmental Services REAC
2890 Woodbridge Avenue, Building 209 Annex Edison, NJ 08837-3679
Telephone 732-321-4200 Facsimile 732-494-4021

LOCKHEED MARTIN

DATE: 01/11/08

TO: Mr. Raj Singhvi, U. S. EPA/ERT

Thru: Vinod Kansal, Analytical Section Leader, REAC Jay Patel for V. Kansal.

FROM: Jay Patel, Inorganic Group Leader, REAC Jay Patel

SUBJECT: Preliminary Results of Project: Lower Silver Creek Tailing site WA# EAC00300

Attached please find the preliminary results of the above referenced project for the following samples.

NO QC EVALUATION/VALIDATION HAS BEEN PERFORMED
DATA VALIDITY IS UNSUBSTANTIATED
AND THE DATA SHOULD BE USED WITH DISCRETION

Chain of Custody No.	# of samples	Matrix	Analyses
300-01/07/08-0001	8	Soil	As, Cd, Cu, Fe, Pb, Hg, Se Metals

CC: Central File # EAC00300

Vinod Kansal — Analytical Section Leader, REAC
G. Newhart — Work Assignment Manager, U. S. EPA/ERT
C. Gussman — Task Leader, REAC
L. Martin, — Hazardous Waste Co-ordinator, REAC

Method REAC SOP 1811/1832

Table 1.x (cont) Results of the Analysis for Metals in Soil
WA # 0-300 Lower Silver Creek tailings site
Results Based on Dry Weight
NO QC EVALUATION / VALIDATION HAS BEEN PERFORMED

Sample No	Method Blank-011008		300-0001		300-0002		300-0003		300-0004		300-0005	
Location	Lab		Location 1		Location 2		Location 3		Location 3B		Location 4	
% Solids	NA		81		86		93		94		91	
Analyte	Result mg/kg	RL mg/kg	Result mg/kg	RL mg/kg	Result mg/kg	RL mg/kg	Result mg/kg	RL mg/kg	Result mg/kg	RL mg/kg	Result mg/kg	RL mg/kg
Arsenic	U	1.50	448	1.71	361	1.63	321	1.52	263	1.51	602	1.56
Cadmium	U	0.400	131	0.457	79.1	0.435	80.3	0.406	88.3	0.401	141	0.415
Copper	U	0.400	1140	0.457	498	0.435	442	0.406	288	0.401	1400	0.415
Iron	U	15.0	16100	17.1	47400	81.5	50500	76.1	57200	75.3	14900	15.6
Lead	U	1.00	15900	1.14	6400	1.09	7440	1.01	8510	1.00	13900	1.04
Mercury	U	0.040	51.8	2.20	10.3	0.816	4.35	0.196	4.27	0.190	14.8	1.93
Selenium	U	1.30	8.50	1.49	17.1	1.41	22.8	1.32	25.3	6.52	7.07	1.35
Zinc	U	3.10	23000	17.7	15100	16.8	14800	15.7	15500	15.6	36100	32.1

RL denotes Reporting Limit
U denotes Not Detected

Table 1.x (cont.) Results of the Analysis for Metals In Soil
WA # 0-300 Lower Silver Creek tailings site
Results Based on Dry Weight
NO QC EVALUATION / VALIDATION HAS BEEN PERFORMED

Sample No.	300-0006		300-0007		300-0008	
Location	Biosolids		Compost		Organic Soil	
% Solids	22		83		77	
Analyte	Result mg/kg	RL mg/kg	Result mg/kg	RL mg/kg	Result mg/kg	RL mg/kg
Arsenic	11.7	5.45	8.32	1.79	5.65	1.86
Cadmium	2.48	1.45	2.20	0.477	U	0.495
Copper	552	1.45	359	0.477	26.8	0.495
Iron	19100	54.5	14600	17.9	6170	18.6
Lead	89.9	3.64	45.1	1.19	122	1.24
Mercury	1.73	0.147	1.59	0.0909	0.0941	0.0456
Selenium	13.8	4.73	8.93	1.56	U	1.61
Zinc	936	11.3	621	3.70	140	3.83

RL denotes Reporting Limit
U denotes Not Detected

EP-C-04-032

CHAIN OF CUSTODY RECORD

No: 300-01/07/08-0001

Site #: 300

Contact Name: Chris Gussman

Contact Phone: 732-321-4237

Lab: REAC

Lab #	Sample #	Location	Analyses	Matrix	Collected	Numb Cont	Container	Preservative	MS/MSD
16130	300-0001	Location 1	TAL metal including Hg	Soil	1/7/2008	1	8 oz jar	4 C	
16131	300-0002	Location 2	TAL metal including Hg	Soil	1/7/2008	1	8 oz jar	4 C	
16132	300-0003	Location 3	TAL metal including Hg	Soil	1/7/2008	1	8 oz jar	4 C	Y
16133	300-0004	Location 3B	TAL metal including Hg	Soil	1/7/2008	1	8 oz jar	4 C	
16134	300-0005	Location 4	TAL metal including Hg	Soil	1/7/2008	1	8 oz jar	4 C	
16135	300-0006	Biosolids	TAL metal including Hg	Biosolids	1/7/2008	1	8 oz jar	4 C	
16136	300-0007	Compost	TAL metal including Hg	Compost	1/7/2008	1	8 oz jar	4 C	
16137	300-0008	Organic Soil	TAL metal including Hg	Organic Soil	1/7/2008	1	8 oz jar	4 C	
	~~300-0009~~	~~Sand~~ CG	~~TAL metal including Hg~~	~~Sand~~	~~1/7/2008~~	~~1~~	~~8 oz jar~~	~~4 C~~	

CG

Special Instructions: TAL Metal analysis including Hg – NO DATA VALIDATION CG
Fe, Cu, Zn, Cd, Se, As, Pb + Hg

Received 4°C [initials] 1/9/08

SAMPLES TRANSFERRED FROM CHAIN OF CUSTODY #

Items/Reason	Relinquished by	Date	Received by	Date	Time	Items/Reason	Relinquished By	Date	Received by	Date	Time
8/ Analysis	[signature]	1/9/08	[signature]	1/9/08	15:00	All / Analysis	[signature]	1/9/08	A A Bhatt	1/9/08	3:25

Appendix B

RUTGERS

New Jersey Agricultural
Experiment Station

Soil Testing Laboratory
Rutgers, The State University
P.O. Box 902
Milltown, NJ 08850-0902
Phone: (732) 932-9295

Soil Test Report

Lab No: 2008-**0039**

Name: Lockheed Martin/REAC
Christopher D. Gussman
Address: 2890 Woodbridge Ave, Bldg. 209 Annex
Edison, NJ 08837

Phone: (732) 321-4237
Fax: (732) 494-4021

Referred To: Rutgers Cooperative Ext. of Middlesex County
(732) 398-5262

Date Received: 01/14/2008
Date Reported: 01/22/2008
Serial No: MX -
Sample ID: 300-Location 1

Crop or Plant

Soil Tests and Interpretation

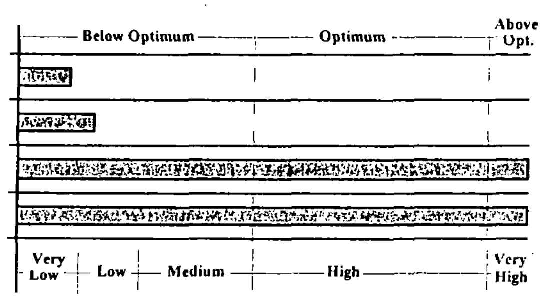
pH: 6.80 Very slightly acidic, slightly higher than desired for most plants; above desired range for acid-loving plants.

Lime Requirement Index: 7.95
Adams-Evans LRI is a measure of the soil's buffering capacity (resistance to change in pH).
It is used to determine liming rate, when necessary.

Macronutrients (pounds/acre)

Phosphorus:	21	(Below Optimum)
Potassium:	51	(Below Optimum)
Magnesium:	598	(Above Optimum)
Calcium:	6299	(Above Optimum)

by Mehlich 3 extraction



Micronutrients (parts per million)

Zinc:	Copper:	Manganese:	Boron:	Iron:
116 (High)	464 (High)	76. (Adequate)	2.1 (Adequate)	157 (High)

Special Tests and Results

Electrical Conductivity: Soluble Salt Level = 0.85 mmho/cm (Somewhat High soluble salt content -- may inhibit germination or 'burn' seedling roots)
Gravel Content: Larger Than 2mm = 15.74%
Mechanical Analysis: Sand = 56%, Silt = 28%, Clay = 16%, Texture = Sandy Loam
Soil Organic Matter: Organic Matter = 4.92%, Organic Carbon = 2.86%

Lime Recommendation

Fertilizer Recommendation

Micronutrient Statements

Zinc toxicity is possibility for certain types of plants. If soil pH is lower (more acidic) than optimum, lime as recommended below. Establish or maintain optimum phosphorus level in soil. If soil organic matter is low, soil amendment with leaf compost can immobilize as well as dilute the soil zinc concentration. See FS721 for more information about soil zinc.

To reduce availability of soil copper to plants, lime the soil to the appropriate pH level (if needed) and amend the soil with organic matter. For more information about copper in soil and plant nutrition, see FS720.

Manganese does not appear to be a limiting factor. Maintain soil pH in the optimum range, as directed in "Recommendations". See FS973 for more information about manganese in soil and plant nutrition.

Boron would not be a limiting factor for most plants. Plant types differ in their requirement for boron, however; certain fruit, vegetables, and field crops have greater need for boron (up to 0.75 ppm). For more information, see FS873.

Plant availability to iron is highly dependent on soil pH. Although soil iron appears plentiful, high soil pH could limit its availability. On the other hand, plant damage due to iron toxicity, though not common, could occur at low soil pH (acidic soil). Maintain soil pH in the optimum range as described in Recommendations. See FS971 for more information.

Comments

Acid-producing soil test results: pH after oxidation = 5.90; Presence of sulfate = (+++); Conclusion: this is not acid-producing soil. Sulfate is relatively abundant, but does not appear to be from oxidation of soil sulfides.

Please refer questions to: Rutgers Cooperative Extension of Middlesex County

(732) 398-5262

Visit the Rutgers Cooperative Extension website at http://www.rce.rutgers.edu

RUTGERS
New Jersey Agricultural Experiment Station

Soil Testing Laboratory
Rutgers, The State University
P.O. Box 902
Milltown, NJ 08850-0902
Phone: (732) 932-9295

Soil Test Report

Lab No: 2008-0040

Name:	Lockheed Martin/REAC Christopher D. Gussman	**Date Received:**	01/14/2008
		Date Reported:	01/22/2008
Address:	2890 Woodbridge Ave, Bldg. 209 Annex Edison, NJ 08837	**Serial No:**	MX -
		Sample ID:	300-Location 2
Phone:	(732) 321-4237		
Fax:	(732) 494-4021		
Referred To:	Rutgers Cooperative Ext. of Middlesex County (732) 398-5262		

Crop or Plant

Soil Tests and Interpretation

pH: 7.25 Very slightly alkaline, indicative of overliming. Possibility of deficiency of the trace nutrients iron, copper, manganese, zinc, and boron.

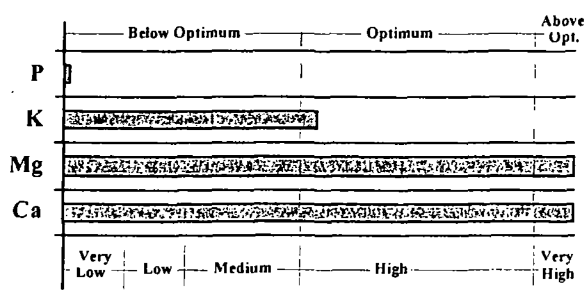
Lime Requirement Index:

Adams-Evans LRI is a measure of the soil's buffering capacity (resistance to change in pH). It is used to determine liming rate, when necessary.

Macronutrients (pounds/acre)

Phosphorus:	2	(Below Optimum)
Potassium:	157	(Optimum)
Magnesium:	413	(Above Optimum)
Calcium:	12294	(Above Optimum)

by Mehlich 3 extraction



Micronutrients (parts per million)

Zinc:	Copper:	Manganese:	Boron:	Iron:
134 (High)	215 (High)	119 (High)	5.1 (Adequate)	472 (High)

Special Tests and Results

Electrical Conductivity: Soluble Salt Level = 1.16 mmho/cm (High soluble salt content -- may 'burn' plant roots, causing drought-like symptoms)
Gravel Content: Larger Than 2mm = 2.94%
Mechanical Analysis: Sand = 68%, Silt = 28%, Clay = 4%, Texture = Sandy Loam
Soil Organic Matter: Organic Matter = 1.71%, Organic Carbon = 0.99%

Lime Recommendation

Fertilizer Recommendation

Micronutrient Statements

Zinc toxicity is possibility for certain types of plants. If soil pH is lower (more acidic) than optimum, lime as recommended below. Establish or maintain optimum phosphorus level in soil. If soil organic matter is low, soil amendment with leaf compost can immobilize as well as dilute the soil zinc concentration. See FS721 for more information about soil zinc.

To reduce availability of soil copper to plants, lime the soil to the appropriate pH level (if needed) and amend the soil with organic matter. For more information about copper in soil and plant nutrition, see FS720.

In excessive amounts, soil manganese can cause plant damage. This occurs primarily in low pH soil. Lime soil as recommended to decrease availability of manganese to plants. Avoid fertilizers that contain manganese. See FS973 for more information.

Boron would not be a limiting factor for most plants. Plant types differ in their requirement for boron, however; certain fruit, vegetables, and field crops have greater need for boron (up to 0.75 ppm). For more information, see FS873.

Plant availability to iron is highly dependent on soil pH. Although soil iron appears plentiful, high soil pH could limit its availability. On the other hand, plant damage due to iron toxicity, though not common, could occur at low soil pH (acidic soil). Maintain soil pH in the optimum range as described in Recommendations. See FS971 for more information.

Comments

Acid-producing soil test results: pH after oxidation = 6.80; Presence of sulfate = (+++); Conclusion: this is not acid-producing soil. Sulfate is relatively abundant, but does not appear to be from oxidation of soil sulfides.

Please refer questions to: Rutgers Cooperative Extension of Middlesex County

(732) 398-5262

Visit the Rutgers Cooperative Extension website at http://www.rce.rutgers.edu

RUTGERS
New Jersey Agricultural
Experiment Station

Soil Testing Laboratory
Rutgers, The State University
P.O. Box 902
Milltown, NJ 08850-0902
Phone: (732) 932-9295

Soil Test Report

Lab No: 2008-**0041**

Name: Lockheed Martin/REAC
Christopher D. Gussman
Address: 2890 Woodbridge Ave, Bldg. 209 Annex
Edison, NJ 08837
Phone: (732) 321-4237
Fax: (732) 494-4021
Referred To: Rutgers Cooperative Ext. of Middlesex County
(732) 398-5262

Date Received: 01/14/2008
Date Reported: 01/22/2008
Serial No: MX -
Sample ID: 300-Location 3

Crop or Plant

Soil Tests and Interpretation

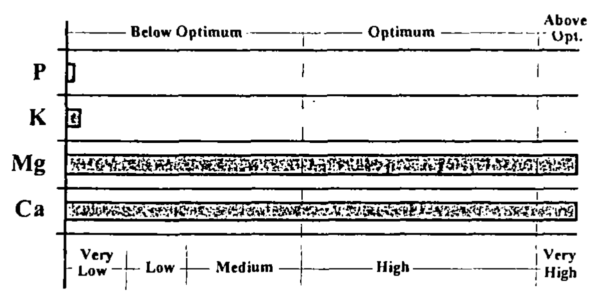
pH: 5.30 Strongly acidic, suitable for the growth of blueberry, potato, azalea, rhododendron, and holly, but too acidic for most other plants.

Lime Requirement Index: 7.60
Adams-Evans LRI is a measure of the soil's buffering capacity (resistance to change in pH).
It is used to determine liming rate, when necessary.

Macronutrients (pounds/acre)

Phosphorus:	3	(Below Optimum)
Potassium:	9	(Below Optimum)
Magnesium:	1217	(Above Optimum)
Calcium:	29779	(Above Optimum)

by Mehlich 3 extraction



Micronutrients (parts per million)

Zinc:	Copper:	Manganese:	Boron:	Iron:
138 (High)	83. (High)	139 (High)	5.8 (Adequate)	902 (High)

Special Tests and Results

Electrical Conductivity: Soluble Salt Level = 3.19 mmho/cm (Very High soluble salt content; will 'burn' plant roots, causing drought-like symptoms)
Gravel Content: Larger Than 2mm = 6.65%
Mechanical Analysis: Sand = 75%, Silt = 14%, Clay = 11%, Texture = Sandy Loam
Soil Organic Matter: Organic Matter = 0.58%, Organic Carbon = 0.34%

Lime Recommendation

Fertilizer Recommendation

Micronutrient Statements

Zinc toxicity is possibility for certain types of plants. If soil pH is lower (more acidic) than optimum, lime as recommended below. Establish or maintain optimum phosphorus level in soil. If soil organic matter is low, soil amendment with leaf compost can immobilize as well as dilute the soil zinc concentration. See FS721 for more information about soil zinc.

To reduce availability of soil copper to plants, lime the soil to the appropriate pH level (if needed) and amend the soil with organic matter. For more information about copper in soil and plant nutrition, see FS720.

In excessive amounts, soil manganese can cause plant damage. This occurs primarily in low pH soil. Lime soil as recommended to decrease availability of manganese to plants. Avoid fertilizers that contain manganese. See FS973 for more information.

Boron would not be a limiting factor for most plants. Plant types differ in their requirement for boron, however; certain fruit, vegetables, and field crops have greater need for boron (up to 0.75 ppm). For more information, see FS873.

Plant availability to iron is highly dependent on soil pH. Although soil iron appears plentiful, high soil pH could limit its availability. On the other hand, plant damage due to iron toxicity, though not common, could occur at low soil pH (acidic soil). Maintain soil pH in the optimum range as described in Recommendations. See FS971 for more information.

Comments

Acid-producing soil test results: pH after oxidation = 4.65; Presence of sulfate = (++++); Conclusion: this is not acid-producing soil. Sulfate is abundant, but does not appear to be from oxidation of soil sulfides.

Please refer questions to: Rutgers Cooperative Extension of Middlesex County

(732) 398-5262

Visit the Rutgers Cooperative Extension website at http://www.rce.rutgers.edu

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Experiment Station

Soil Testing Laboratory
Rutgers, The State University
P.O. Box 902
Milltown, NJ 08850-0902
Phone: (732) 932-9295

Soil Test Report

Lab No: 2008-**0042**

Name: Lockheed Martin/REAC
Christopher D. Gussman
Address: 2890 Woodbridge Ave, Bldg. 209 Annex
Edison, NJ 08837
Phone: (732) 321-4237
Fax: (732) 494-4021
Referred To: Rutgers Cooperative Ext. of Middlesex County
(732) 398-5262

Date Received: 01/14/2008
Date Reported: 01/22/2008
Serial No: MX -
Sample ID: 300-Location 4

Crop or Plant

Soil Tests and Interpretation

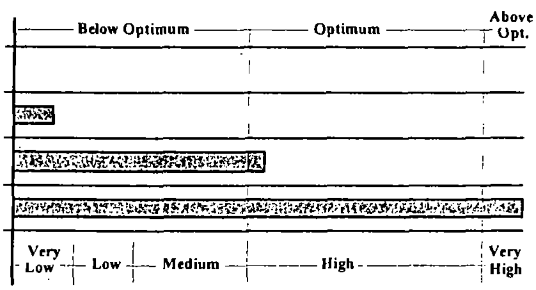
pH: 7.25 Very slightly alkaline, indicative of overliming. Possibility of deficiency of the trace nutrients iron, copper, manganese, zinc, and boron.

Lime Requirement Index:
Adams-Evans LRI is a measure of the soil's buffering capacity (resistance to change in pH). It is used to determine liming rate, when necessary.

Macronutrients (pounds/acre)

Phosphorus:	1	(Below Optimum)
Potassium:	26	(Below Optimum)
Magnesium:	157	(Optimum)
Calcium:	6757	(Above Optimum)

by Mehlich 3 extraction



Micronutrients (parts per million)

Zinc:	Copper:	Manganese:	Boron:	Iron:
110 (High)	722 (High)	149 (High)	8.2 (Adequate)	396 (High)

Special Tests and Results

Electrical Conductivity: Soluble Salt Level = 1.23 mmho/cm (High soluble salt content -- may 'burn' plant roots, causing drought-like symptoms)
Gravel Content: Larger Than 2mm = 9.39%
Mechanical Analysis: Sand = 69%, Silt = 24%, Clay = 7%, Texture = Sandy Loam
Soil Organic Matter: Organic Matter = 1.13%, Organic Carbon = 0.65%

Lime Recommendation

Fertilizer Recommendation

Micronutrient Statements

Zinc toxicity is possibility for certain types of plants. If soil pH is lower (more acidic) than optimum, lime as recommended below. Establish or maintain optimum phosphorus level in soil. If soil organic matter is low, soil amendment with leaf compost can immobilize as well as dilute the soil zinc concentration. See FS721 for more information about soil zinc.

To reduce availability of soil copper to plants, lime the soil to the appropriate pH level (if needed) and amend the soil with organic matter. For more information about copper in soil and plant nutrition, see FS720.

In excessive amounts, soil manganese can cause plant damage. This occurs primarily in low pH soil. Lime soil as recommended to decrease availability of manganese to plants. Avoid fertilizers that contain manganese. See FS973 for more information.

Boron would not be a limiting factor for most plants. Plant types differ in their requirement for boron, however; certain fruit, vegetables, and field crops have greater need for boron (up to 0.75 ppm). For more information, see FS873.

Plant availability to iron is highly dependent on soil pH. Although soil iron appears plentiful, high soil pH could limit its availability. On the other hand, plant damage due to iron toxicity, though not common, could occur at low soil pH (acidic soil). Maintain soil pH in the optimum range as described in Recommendations. See FS971 for more information.

Comments

Acid-producing soil test results: pH after oxidation = 7.05; Presence of sulfate = (++++); Conclusion: this is not acid-producing soil. Sulfate is abundant, but does not appear to be from oxidation of soil sulfides.

Please refer questions to: Rutgers Cooperative Extension of Middlesex County

(732) 398-5262

Visit the Rutgers Cooperative Extension website at http://www.rce.rutgers.edu

RUTGERS
New Jersey Agricultural Experiment Station

Plant Diagnostic and Soil Testing Laboratories
Soil Testing Laboratory
ASB-II, Room 152
New Jersey Agricultural Experiment Station
Rutgers, The State University of New Jersey
57 US Highway 1
New Brunswick, NJ 08901

http://njaes.rutgers.edu/services
soiltest@aesop.rutgers.edu

732-932-7000, Ext. 4231
Fax: 732-932-9292

Soil Test Report

Lab No: 2008 - **0043**

Name: Lockheed Martin/REAC
Christopher D. Gussman
Address: 2890 Woodbridge Ave, Bldg. 209 Annex
Edison, NJ 08837

Phone: (732) 321-4237
Fax: (732) 494-4021

Referred Rutgers Cooperative Ext. of Middlesex County
(732) 398-5262

Date Received: 01/14/2008
Date Reported: 01/18/2008
Serial No: MX -
Sample ID: 300-Bs

Crop or Plant

Soil Tests and Interpretation - by Saturated Media Extract (for organic matter-based soil)

pH: 6.75 Very slightly acidic, slightly higher than desired for most plants; above desired range for acid-loving plants.

Macronutrients (parts per million)

Phosphorus:	12	(High)
Potassium:	60	(Acceptable)
Magnesium:	130	(Optimum)
Calcium:	518	(Very High)

Micronutrients (parts per million)

Zinc:	Copper:	Manganese	Boron:	Iron:
0.23(Low)	0.38(Adequate)	0.31(Adequate)	0.30(Adequate)	4.20(High)

Special Tests and Results

Electrical Conductivity: Soluble Salt Level = 7.90 mmho/cm (Very High soluble salt content; will 'burn' plant roots, causing drought-like symptoms)

Loss On Ignition: Organic Matter = 65.20%, Organic Carbon = 37.82%

Inorganic Nitrogen: Nitrate-N = 32 ppm (Low), Ammonium-N = 675 ppm (Very High)

Appendix C

Lockheed Martin Technology Services Group
Environmental Services REAC
2890 Woodbridge Avenue, Building 209 Annex Edison, NJ 08837-3679
Telephone 732-321-4200 Facsimile 732-494-4021

LOCKHEED MARTIN

DATE: 04/03/08

TO: Mr. Raj Singhvi, U. S. EPA/ERT

Thru: Vinod Kansal, Analytical Section Leader, REAC Vinod Kansal

FROM: Jay Patel, Inorganic Group Leader, REAC Jay Patel

SUBJECT: Preliminary Results of Project Lower Silver Creek site WA# EAC00300

Attached please find the preliminary results of the above referenced project for the following samples.

NO QC EVALUATION/VALIDATION HAS BEEN PERFORMED
DATA VALIDITY IS UNSUBSTANTIATED
AND THE DATA SHOULD BE USED WITH DISCRETION

Chain of Custody No.	# of samples	Matrix	Analyses
300-03/21/08-0002	12	Water	Metals - Al, As, Cd, Cr, Fe Se, Mg, Zn

CC: Central File # EAC00300

Vinod Kansal — Analytical Section Leader, REAC

G. Newhart — Work Assignment Manager, U. S. EPA/ERT

C. Gussman — Task Leader, REAC

L. Martin. — Hazardous Waste Co-ordinator, REAC

Method REAC SOP 1811/1832

Table 1.x (cont.) Results of the Analysis for Metals in Water
WA # 0-300 Lower Silver Creek Site
NO QC EVALUATION HAS BEEN PERFORMED

Sample No.	Method Blank-032708		300-0010		300-0011		300-0012		300-0013		300-0014	
Location	Lab		control		control		control		+10% Compost		+10% Compost	
Analyte	Result µg/L	RL µg/L	Result µg/L	RL µg/L	Result µg/L	RL µg/L	Result µg/L	RL µg/L	Result µg/L	RL µg/L	Result µg/L	RL µg/L
Aluminum	U	100	U	100	U	100	U	100	U	100	U	100
Arsenic	U	17.0	U	17.0	U	17.0	U	17.0	20.7	17.0	20.0	17.0
Cadmium	U	3.00	725	3.00	717	3.00	755	3.00	201	3.00	224	3.00
Copper	U	4.00	5.23	4.00	4.99	4.00	7.85	4.00	65.9	4.00	37.1	4.00
Iron	U	25.0	U	25.0	U	25.0	U	25.0	U	25.0	U	25.0
Lead	U	10.0	U	10.0	U	10.0	U	10.0	U	10.0	U	10.0
Magnesium	U	160	41200	160	41900	160	47200	160	96200	160	83500	160
Mercury	U	0.200	U	0.200	U	0.200	U	0.200	U	0.200	U	0.200
Selenium	U	15.0	U	15.0	U	15.0	U	15.0	U	15.0	U	15.0
Zinc	U	6.00	19200	6.00	19600	6.00	20500	6.00	6310	6.00	6340	6.00

RL denotes Reporting Limit
U denotes Not Detected

Table 1.x (cont.) Results of the Analysis for Metals in Water
WA # 0-300 Lower Silver Creek Site
NO QC EVALUATION HAS BEEN PERFORMED

Sample No.	300-0015		300-0016		300-0017		300-0018		300-0019		300-0020	
Location	+10% Compost		+10% Compost+P		+10% Compost+P		+10% Compost+P		+10% Compost+lime+P		+10% Compost+lime+P	
Analyte	Result µg/L	RL µg/L	Result µg/L	RL µg/L	Result µg/L	RL µg/L	Result µg/L	RL µg/L	Result µg/L	RL µg/L	Result µg/L	RL µg/L
Aluminum	U	100	U	100	U	100	U	100	U	100	U	100
Arsenic	23.5	17.0	44.2	17.0	47.0	17.0	75.3	17.0	107	17.0	78.7	17.0
Cadmium	199	3.00	287	3.00	286	3.00	260	3.00	204	3.00	172	3.00
Copper	39.9	4.00	110	4.00	98.0	4.00	221	4.00	264	4.00	178	4.00
Iron	U	25.0	U	25.0	U	25.0	U	25.0	U	25.0	U	25.0
Lead	U	10.0	U	10.0	U	10.0	U	10.0	U	10.0	U	10.0
Magnesium	86200	160	107000	160	106000	160	111000	160	133000	160	126000	160
Mercury	U	0.200	U	0.200	U	0.200	U	0.200	U	0.200	U	0.200
Selenium	U	15.0	U	15.0	U	15.0	U	15.0	U	15.0	U	15.0
Zinc	5970	6.00	14900	6.00	15200	6.00	15800	6.00	13200	6.00	10200	6.00

RL denotes Reporting Limit
U denotes Not Detected

Table 1.x (cont.) Results of the Analysis for Metals in Water
WA # 0-300 Lower Silver Creek Site
NO QC EVALUATION HAS BEEN PERFORMED

Sample No. 300-0021
Location +10% Compost+lime+P

Analyte	Result µg/L	RL µg/L
Aluminum	U	100
Arsenic	83.7	17.0
Cadmium	182	3.00
Copper	226	4.00
Iron	U	25.0
Lead	U	10.0
Magnesium	122000	160
Mercury	U	0.200
Selenium	U	15.0
Zinc	11800	6.00

RL denotes Reporting Limit
U denotes Not Detected

Table 2.x (cont.) Results of the MS/MSD Analysis for Metals in Water
WA # 0-300 Lower Silver Creek Site
NO QC EVALUATION HAS BEEN PERFORMED

Sample No. 300-0311

Analyte	Sample Result µg/L	MS Spike Added µg/L	MS Result µg/L	MS % Rec	MSD Spike Added µg/L	MSD Result µg/L	MSD % Rec	RPD	Recommended QC Limits % Rec	Recommended QC Limits RPD
Aluminum	U	1111	1130	102	1111	1190	107	5	75-125	20
Arsenic	U	55.6	49.9	90	55.6	52.9	95	6	75-125	20
Cadmium	717	111	816	89	111	836	107	2	75-125	20
Copper	4.99	111	118	102	111	123	106	4	75-125	20
Iron 2599	U	1111	1110	100	1111	1150	104	4	75-125	20
Lead	U	55.6	58.5	105	55.6	58.5	105	0	75-125	20
Magnesium	41900	1111	42400	NC	1111	43300	NC	2	75-125	20
Mercury	U	2.00	2.30	115	2.00	2.13	107	8	75-125	20
Selenium	U	55.6	57.4	103	55.6	59.2	107	3	75-125	20
Zinc	19800	111	19700	NC	111	20100	NC	2	75-125	20

NC denotes Not Calculated due to high concentration of analyte in the sample.

Table 2.x (cont.) Results of the MS/MSD Analysis for Metals in Water
WA # 0-300 Lower Silver Creek Site
NO QC EVALUATION HAS BEEN PERFORMED

Sample No. 300-0019

Analyte	Sample Result µg/L	MS Spike Added µg/L	MS Result µg/L	MS % Rec	MSD Spike Added µg/L	MSD Result µg/L	MSD % Rec	RPD	Recommended QC Limits % Rec	Recommended QC Limits RPD
Aluminum	U	1111	1180	106	1111	1190	107	1	75-125	20
Arsenic	107	55.6	159	94	55.6	161	97	1	75-125	20
Cadmium	204	111	308	94	111	310	95	1	75-125	20
Copper	264	111	378	103	111	379	104	0	75-125	20
Iron	U	1111	1120	101	1111	1130	102	1	75-125	20
Lead	U	55.6	57.6	104	55.6	58.1	105	1	75-125	20
Magnesium	133000	1111	132000	NC	1111	133000	NC	1	75-125	20
Mercury	U	2.00	2.25	113	2.00	2.26	113	0	75-125	20
Selenium	U	55.6	68.5	123	55.6	70.6	127 *	3	75-125	20
Zinc	13200	111	13000	NC	111	13000	NC	0	75-125	20

* denotes a value that exceeds the recommended QC limits
NC denotes Not Calculated due to high concentration of analyte in the sample

LOWER SILVER CREEK

CHAIN OF CUSTODY RECORD

No: 300-03/21/08-0002

Site #: 300

Contact Name: Chris Gussman

Contact Phone: 7323214237

Lab: REAC

Lab #	Sample #	Location	Analyses	Matrix	Collected	Numb Cont	Container	Preservative	MS/MSD
16485	300-0010	control	TAL metal ~~no Hg~~	pore water	3/26/2008	1	500 ML bottle	4 C / HNO_3	
16486	300-0011	control	TAL metal ~~no Hg~~	pore water	3/26/2008	1	500 ML bottle	4 C	Y
16487	300-0012	control	TAL metal ~~no Hg~~	pore water	3/26/2008	1	500 ML bottle	4 C	
16488	300-0013	+10%Compost	TAL metal no Hg	pore water	3/26/2008	1	500 ML bottle	4 C	
16489	300-0014	+10%Compost	TAL metal ~~no Hg~~	pore water	3/26/2008	1	500 ML bottle	4 C	
16490	300-0015	+10%Compost	TAL metal ~~no Hg~~	pore water	3/26/2008	1	500 ML bottle	4 C	
16491	300-0016	+10%compost+P	TAL metal ~~no Hg~~	pore water	3/26/2008	1	500 ML bottle	4 C	
16492	300-0017	+10%compost+P	TAL metal ~~no Hg~~	pore water	3/26/2008	1	500 ML bottle	4 C	
16493	300-0018	+10%compost+P	TAL metal ~~no Hg~~	pore water	3/26/2008	1	500 ML bottle	4 C	
16494	300-0019	+10%compost+lime+P	TAL metal ~~no Hg~~	pore water	3/26/2008	1	500 ML bottle	4 C	Y
16495	300-0020	+10%compost+lime+P	TAL metal ~~no Hg~~	pore water	3/26/2008	1	500 ML bottle	4 C	
16496	300-0021	+10%compost+lime+P	TAL metal no Hg	pore water	3/26/2008	1	500 ML bottle	4 C	

Special Instructions: Metals = As, Cd, Cu, Fe, Se, Al, Mg, Zn, Pb; Hg ~~Hg~~ Results only no data validation

Samples kept in SRU#1 Elon Received Cold TM 3/26/08 till 3/27/08. TM 3/26/08 3/26/08

SAMPLES TRANSFERRED FROM CHAIN OF CUSTODY #

Items/Reason	Relinquished by	Date	Received by	Date	Time	Items/Reason	Relinquished By	Date	Received by	Date	Time
[illegible]	[signature]	3/21/08	[signature]	3/26/08	15:00	All/Analysis	[signature]	3/27/08	[signature]	3/27/08	8:30